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NEW EQUIPMENT FOR MILLING DOLOMITE

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A centrifugal mill MV intended for milling non-plastic materials has been designed, undergone industrial testing, and has been implemented at several factories.

Mechanical destruction of solid materials intended to reduce their size and separate them into components is often applied in different industrial sectors and is one of the most important operations in preparing materials for further processing. Lump dolomite is subjected to several operations at glass-making factories: crushing to the size of pebble, milling the crushed product to a dust-like state, and subsequent screening of the milled product, milling being the least effective operation. The reason for this is imperfect milling equipment used at the factories, which restricts their possibilities and prospects.

At present machinery for grinding mineral materials to obtain close-grained factions is mostly based on ball and rod drum mills and to a much lesser extent on hammer crushers, which have certain drawbacks. All drum mills use the same principle of destroying material at the expense of energy of milling bodies dropping and rolling inside the drum, which are usually steel rods or steel balls raised to a certain height by the drum revolving at a small angular velocity. Since only an insignificant part of the energy imparted to milling bodies is used directly for material breaking, whereas the major part is consumed in wear of the milling bodies and the drum lining or transmitted into heat, the efficiency of the milling process is low.

Ball mills have the following drawbacks: a high level of electricity and metal consumption; contamination of the target product with iron; a cumbersome design of mills, which makes it necessary to install them on heavy foundations; the difficulty of controlling the milling process; strict requirements imposed on initial material moisture (in the case of dry milling). It should be noted as well that for the mill to be efficient, the maximum size of loaded components has to be limited (not more than 20 mm). However, a material with such particle size easily absorbs atmospheric moisture and rapidly transforms into a clay-like mixture even in short-term storage in open air, whereas moisture removal involves additional expenses related to preliminary drying.

The North-Caucasus State Technological University (CKGTU) has developed a new method for self-crushing of materials (RF patent No. 2078613), according to which the milled material is formed as a vertical cylindric column. Its lower part rotates with a peripheral velocity of 10 – 70 m/sec and the pressure of material on this part of the column is maintained equal to 0.005 – 0.045 MPa. Grinding of material is implemented in the lower part of the column due to mutual collision of particles and lumps against each other and their subsequent abrasion in the upper layers of the column. This method has been implemented in the development of a centrifugal vertical mill (RF patent No. 2084787).

The MV mill (Fig. 1) consists of a vertical cylindrical body *1* and a coaxially located shaft *2* inserted in bearings *3*

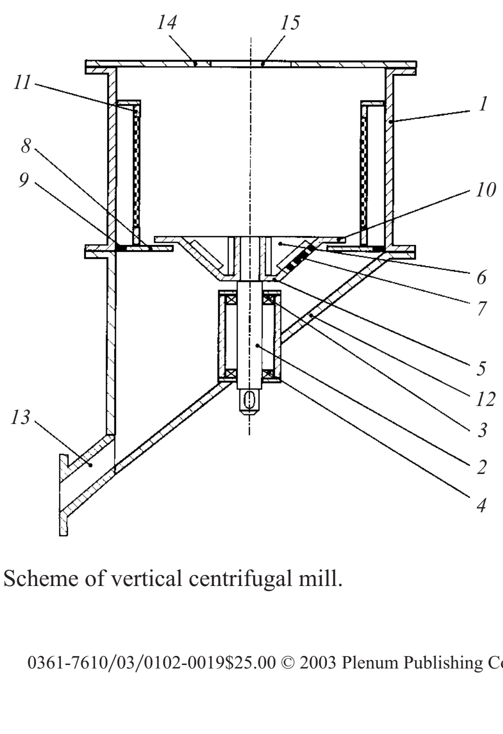

Fig. 1. Scheme of vertical centrifugal mill.

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TABLE 1

Size class, mm	Content, %, of size class in the mill	
	centrifugal	ball
More than 2.5	17.1	44.0
2.0 – 2.5	3.6	5.1
1.6 – 2.0	3.3	4.8
0.4 – 1.6	14.1	15.1
0.25 – 0.4	4.6	5.4
Less than 0.25	57.3	25.6

and *4*. In its lower part the shaft is connected with a drive (not indicated in Fig. 1) and its upper part is connected with a cup-shaped rotor *5* shaped as an upturned hollow truncated cone. The rotor is divided by vertical partitions *6* into sections. Each section has screening surfaces in the form of sieves *7* inserted in the slanted wall of the rotor. A ring *8* with windows *9* is fixed to the body and its upper surface is located beneath the horizontal site *10* of the rotor. A perforated cylinder *11* is installed above the ring concentrically with the body. The lower part of this cylinder encompasses the peripheral part of the horizontal site in such a way that chambers for discharging the finished product from the working zone of the mill are formed between the body, the ring, and the perforated cylinder. A hopper *12* is fixed to the lower flange of the body and has a branch pipe *13* to remove the milled material from the mill. The top of the body is covered by the lid *14* that has a charge opening *15* to insert a funnel, through which lump material is continuously fed into the mill.

The centrifugal mill operates as follows. Initial material is continuously loaded into the body via the charge opening and forms a constantly renewed column above the rotor. When the electric engine is switched on, the material particles located in the rotor cavities start moving toward the periphery under the centrifugal effect and simultaneously become pressed against the vertical partitions, penetrate into the active milling zone, and become crushed, as a consequence of impacts, shearing, and abrasion. Particles of target fractions penetrate into the hopper and are discharged from the mill via the outlet branch pipe.

The new mills have been repeatedly tested in milling various raw materials: manganese, copper, and lead-zinc ore, lime, dolomite, coke, cement clinker, various carbonaceous materials, etc. [1]. All testing confirmed the promise of the new milling method due to the possibility of combining the crushing and milling operations in a single unit (the particle size of initial material can be up to 80 mm), absence of milling bodies and specific foundations, a low content of iron in the finished product, low specific consumption of electricity and metal, simplicity of production, maintenance and operation, low specific metal consumption, high efficiency (over 1 ton/m^3 per hour), low noise level (less than 65 dB at a distance of 1.5 m), insignificant wear of working elements (less than 100 g/ton), etc.

To study the possibility of using the new type of mill in the production of powdered dolomite for glass production, a MV mill with a rotor diameter of 1 m was installed on an open site of the material-preparation division of the Iristonsteklo Company (North Osetia-Alania).

Testing was performed as follows. Large-lump dolomite (fractions from 50 to 250 mm) from the Dlinodolinskoe deposit was loaded into the centrifugal mill. The height of the column over the rotor inside the mill body was maintained at the level of 300 – 400 mm, the rotational speed of the rotor was 250 min^{-1}, the size of the sieve cells in the rotor screening surfaces was 3 mm, and the testing lasted 6 h with a continuous milling cycle.

The results of testing the MV mill were matched with the results of the ball mill ShM-2700x1450 with a peripheral discharge, which can mill dolomite sized below 20 mm (Table 1).

The output of the finished product in the centrifugal mill was 3.5 – 4.5 ton/h, whereas that of the ball mill was around 3 ton/h. The quality of the milled product was better in the MV mill.

Based on the testing results, design and specifications documents for MV-1 centrifugal mills with a rotor diameter of 1 m and output up to 5 ton/h of initial products were developed. Following the recommendations of the SKGTU, the Agat JSC (former Georgievskii Mechanical Repair Plant) produced several of such mills. The MV-1 mills are being successfully used at glass, electrode, and brick factories and at factories producing construction materials.

Wide implementation of centrifugal mills MV-1 in the process schemes for producing milled dolomite for glass will decrease production cost and, accordingly, increase efficiency. It should be noted as well that construction of a modern enterprise for processing lump dolomite next to a large deposit (which is Kavdolomit in North Osetia-Alania) using large-size vertical centrifugal mills will make it possible to simplify glass-production technology by using available finely milled dolomite.

REFERENCES

1. V. N. Khetagurov, *Development and Design of Centrifugal Vertical Mills* [in Russian], Terek, Vladikavkaz (1999).